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DISINTEGRATION OF GIRDLED WESTERN HEMLOCK AND GRAND FIR

by

Austin E. Helmers

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DISINTEGRATION OF GIRDLED WESTERN HEMLOCK AND GRAND FIR

By

Austin E. Helmers [1]

INTRODUCTION

The occurrence of overmature defective trees is responsible for some of the most difficult management problems in the western white pine type. Grand fir and western hemlock in particular are highly susceptible to wood-rotting fungi. In addition, because of their shade tolerance, they often inhibit or prevent establishment and growth of the more desirable but less shade-tolerant species such as western white pine. Hence, many of the management practices for the white pine type provide for the removal of trees of undesirable form, condition, or species.

Girdling is one method of removing such trees. This method was extensively used by the U. S. Forest Service between 1915 and 1930 on timber sales in the western white pine type. Although girdling low-value trees was discontinued as a stand improvement measure after 1930 because of the high fire hazard of the resulting snags (Figure 1), there were reasons to consider the method worthy of further study. For example, it is a comparatively cheap and effective way to destroy an occasional large tree, such as a wolf tree which is suppressing desirable reproduction. Tests [2] were made, accordingly, to determine the effect of girdling on cone production, mortality, rate of disintegration of trees, and damage to reproduction. Results of these studies are described in this report.

DESCRIPTION OF STUDY PLOTS

Two sets of two adjacent plots were established on north-facing slopes on the Deception Creek Experimental Forest [3]. One set was located on a lower slope on Sands Creek and the other on a middle slope on Tamarack Hill. One plot of each set was girdled and the other plot left ungirdled as a check on cone production.

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[1] Division of Forest Management Research.

[2] These tests were planned by Kenneth P. Davis, formerly a member of the Northern Rocky Mountain Forest and Range Experiment Station, and established under his supervision.

[3] Located in the Coeur d'Alene National Forest, Idaho.

The Sands Creek plots were located in a decadent stand 200+ years of age from which the white pine was removed between 1914 and 1916. The residual stand was composed of western hemlock and grand fir (table 1). The Tamarack Hill plots were located in a virgin 160-year-old white pine stand with a heavy admixture of hemlock and grand fir. The Sands Creek plot contained 5.5 acres and the Tamarack Hill plot one acre.

Table 1.--Description of girdled stands

Location	Trees per acre		Average diameter		Range in diameter	
	Western hemlock	Grand fir	Western hemlock	Grand fir	Western hemlock	Grand fir
	No.	No.	Inches	Inches	Inches	Inches
Sands Creek	10	5	28	26	9 - 46	18 - 41
Tamarack Hill	83	4	11	9	7 - 19	8 - 11

GIRDLING METHOD

The trees were girdled with axes, using the "notch" method. The notches exposed a strip of wood 3 to 4 inches wide and were made to a depth of 2 to 3 inches (Figure 2).

Trees on the Sands Creek plot were girdled in June, 1935. The notches were located at an average of 2½ feet above the ground line. Trees on the Tamarack Hill plot were girdled in October, 1934, but these trees were renotched in August, 1935, at a height ranging from two to five feet above the ground line because the initial girdling did not appear to have been thorough enough to cause complete killing. The following numbers of hemlock and grand fir were girdled on the two areas:

	Hemlock	Grand fir
Sands Creek	55	29
Tamarack Hill	83	4

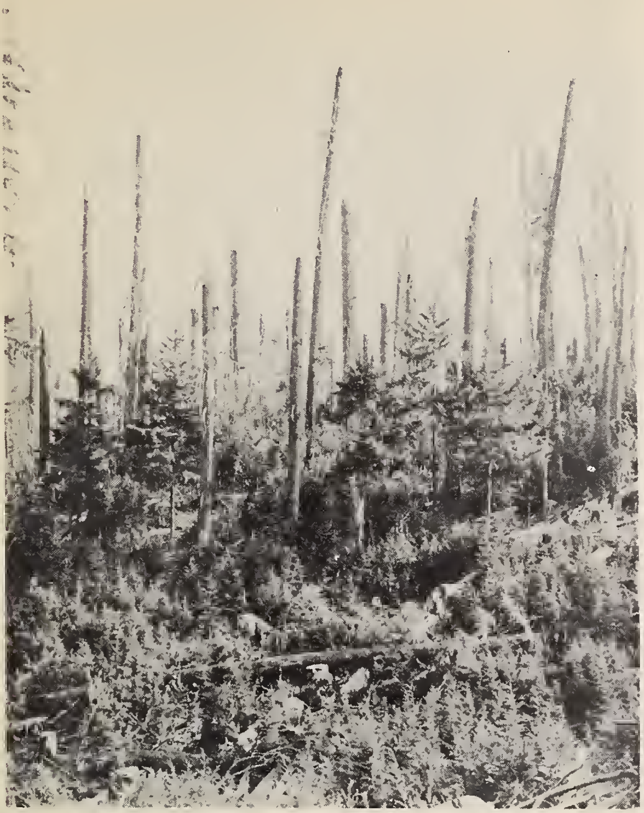

Figure 1.—Snags, 20 years after girdling defective western hemlock left after logging, near Rock City, Coeur d'Alene National Forest. The snags still are an extremely high fire hazard. (Girdling large numbers of big diameter trees is no longer practiced.)

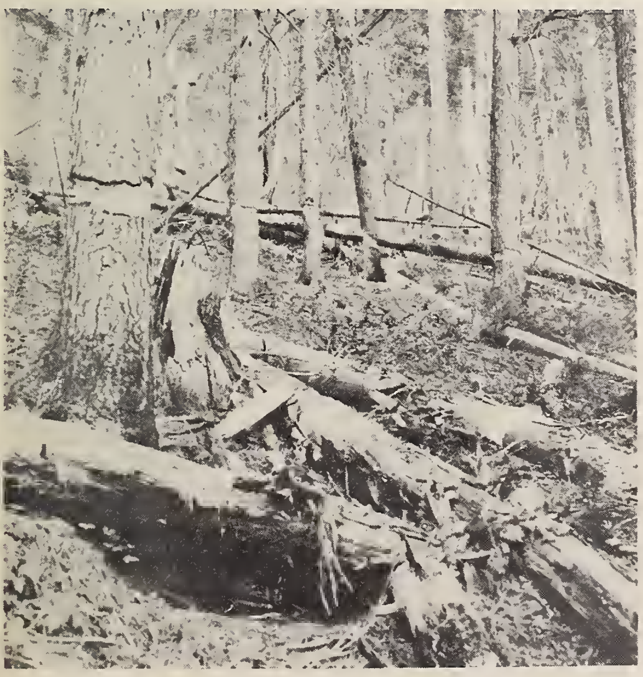

Figure 2.—Girdled western hemlock on Tamarack Hill, Deception Creek Experimental Forest.

RESULTS

Cone Production

It has been believed by some that girdling of trees stimulated seed production. Such a response with hemlock and grand fir, resulting in an increase of reproduction of these species, usually would be undesirable. In an earlier study, Brewster and Larsen (1) [4], were not able to determine if girdling actually resulted in increased seed production. Fire, insect attack, and mechanical injuries such as partial girdling due to logging damage were all found by Watson (4) to stimulate cone production. However, the girdling performed in the experiments reported here did not cause an increase in cone production (tables 2 and 3).

Girdled and ungirdled trees in the intermediate and suppressed crown classes produced the fewest cones and trees in the dominant and codominant crown classes produced the heaviest cone crops. The same direct relationship was observed between cone production and tree height.

Girdling has been used in at least one instance for the specific purpose of increasing seed production in hardwoods (2). Thus, the belief that unfavorable conditions stimulate seed production has support. On the other hand, there is evidence to show that unfavorable conditions are not the usual cause of seed production in plants, though it might at times be an inducing factor (3). Seed production usually follows a period of high food-producing activity in most plants. Perhaps injuries which block the downward movement of elaborated foods produce a similar physiological state by causing the accumulation of such foods in the crown above the point of injury.

The present experiment failed to show a substantial effect of girdling upon cone production. Hence, the relative advantages of girdling over other methods of tree removal must be judged on the basis of factors other than cone production.

Decline in Vigor

The effect of girdling western hemlock and grand fir first became evident in the yellowing of the needles. This occurred as early as two months after girdling but was delayed as long as nine months in some cases (table 4). Most of the trees died about 24 months after girdling, and all of them were dead in 48 months. Symptoms indicating a decline in vigor appeared earlier on grand fir than on hemlock.

The apparent lag in decline of vigor of Tamarack Hill trees as compared to Sands Creek trees may be partly due to the ineffective first girdling on

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[4] Numbers in parentheses refer to literature cited, page 14.

Table 2.--Cone production of hemlock and grand fir trees during the first and second years following girdling, compared with cone production of ungirdled trees. Sands Creek.

Size of cone crop 1/	Proportion of trees producing each size crop							
	Western hemlock				Grand fir			
	First year		Second year		First year		Second year	
	Girdled	Ungirdled	Girdled	Ungirdled	Girdled	Ungirdled	Girdled	Ungirdled
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
None	5	8	6	10	97	100	23	6
Very poor	16	19	0	0	-	-	-	-
Poor	22	8	6	25	3	0	28	11
Fair	31	27	88	65	0	0	21	35
Good	24	30	0	0	0	0	28	48
Very good	2	8	0	0	-	-	-	-
All classes	100	100	100	100	100	100	100	100

1/ Cone crop classification based on counts and general density of cones as follows:

Class	Western Hemlock	Grand Fir
None	0 cones	0 cones
Very poor	1 - 10 cones	-
Poor	11 - 40 cones	1 - 20 cones
Fair	41+ cones up to good crop	21 - 40 cones
Good	Branches sag with weight of cones	41+ cones
Very good	Branches drooping heavily; distinctly overloaded.	-

Table 3.--Cone production of hemlock during the first and second years following girdling compared with cone production of ungirdled hemlock. Tamarack Hill.

Size of cone crop 1/	Proportion of trees producing each size crop			
	First year		Second year	
	Girdled	Ungirdled	Girdled	Ungirdled
	Percent	Percent	Percent	Percent
None	11	0	6	0
Very poor	56	50	0	0
Poor	11	25	22	77
Fair	22	16	72	23
Good	0	9	0	0
Very good	0	0	0	0
All classes	100	100	100	100

1/ Cone crop classification based on counts and general density of cones as follows:

None - 0 cones

Very poor - 1-10 cones

Poor - 11-40 cones

Fair - 41+ cones up to good crop

Good - branches sag with weight of cones

Very good - branches drooping heavily; distinctly overloaded

Table 4.--Decline in vigor of girdled western hemlock and grand fir

Symptom	Species	Time of occurrence after girdling					
		Sands Creek			Tamarack Hill		
		Begins	Peak	Ends	Begins	Peak	Ends
		Months	Months	Months	Months	Months	Months
Foliage distinctly yellow-green	Hemlock	2	12	14	9	9 - 12	21
	Grand fir	2	4	14			
Tree definitely unhealthy in appearance	Hemlock	4	12 - 13	24	9	20 - 22	33
	Grand fir	4	4 - 12	16			
1/4 of inner leaves dead	Hemlock	4	24	24	9	22 - 33	33
	Grand fir	4	14 - 16	24			
Foliage almost dead	Hemlock	4	28	28	10	21 - 48	48
	Grand fir	4	24	28			
Foliage all dead	Hemlock	12	28	36	12	21 - 48	48
	Grand fir	12	24 - 28	36			

the Tamarack Hill area that was not corrected until 10 months later. The lag may also be partly due to the younger age and greater vigor of the Tamarack Hill stand.

Delayed mortality following girdling may be desirable as a means of opening up a stand gradually, especially if large numbers of trees are to be removed. The initial shock to the residual stand following direct felling evidently could be minimized and the adjustment to open conditions spread over a period of three to four years, and perhaps even longer, by girdling. The girdled trees would afford much shade protection for several years after the needles had fallen. Such protection may be of value in a residual stand of thin-barked white pine susceptible to heat injury.

Rate of Disintegration

Disintegration of girdled trees commenced when the needles began to fall. This was as early as four months after girdling on western hemlock and as late as one year in the case of grand fir (table 5). Defoliation was practically complete in three to four years after girdling.

Consistent records of features such as bark cracking and scaling and the breaking up of the branch system were difficult to make because the descriptions of these criteria were arbitrary and a number of different observers were involved. Inconsistencies also appear due to the breaking up of the main stem of the trees, resulting in a changing basis for successive observations. Despite these limitations, however, table 5 shows that the branch system breaks down gradually, progressing from the fine branchlets to the larger primary branches.

Bole breakage (Figure 3), probably the most important feature of disintegration, began two and three-fourths to three years after girdling (table 5). All hemlock on the Sands Creek area had broken off at least once by the eleventh year after girdling. All of the grand firs sustained first breaks by the eighth year. Of the Tamarack Hill trees, however, 13 percent were unbroken 12 years after girdling. A second breakage of stems commenced six to seven years after girdling on the Sands Creek area and 10 years after girdling on the Tamarack Hill area.

The larger hemlocks on the Sands Creek area tended to break off first. Breaks during subsequent years were on trees of successively smaller diameter. Conversely, the smaller grand fir trees on the Sands Creek area, and the smaller trees of both species on the Tamarack Hill area broke first. Later breaks were on successively larger trees.

Roughly two-thirds of the bole length was lost in the first break. Approximately one-half to three-fourths of the remaining height was lost with the second break. Many early breaks on Tamarack Hill were at the point of girdling, however, due to a combination of high winds and deep girdling notches.

Table 5.--Disintegration of girdled western hemlock and grand fir

Character	Species	Time of occurrence after girdling					
		Sands Creek			Tamarack Hill [1]		
		Begins	Peak	Ends	Begins	Peak	Ends
		Years	Years	Years	Years	Years	Years
Needles begin to fall	Hemlock	1/3	1-1/4	2-1/3	2/3	1-2/3)	2-3/4
	Grand fir	1	1-1/3	2-1/3		to 2)	
Needles mostly fallen	Hemlock	1	2-1/3	3	1	2-3/4)	
	Grand fir	1	2-1/3) to 3)	3		to 4)	4
Bark Cracked	Hemlock	3	6 to 7	11+	4	7 to 8	12+
	Grand fir	3	5	8			
Bark begins to scale off	Hemlock	3	8	11+	4	4	12+
	Grand fir	3	6	8			
Branchlets 1/4 gone	Hemlock	3	5 to 6	9	5	8 to 9	12+
	Grand fir	3	3 to 4	6			
Branchlets 3/4 gone	Hemlock	3	6	9			
	Grand fir	3	3 to 6	9			
Secondary branches 1/4 gone	Hemlock	3	6 to 7	8			
	Grand fir	3	5 to 6	11+			
Secondary branches 3/4 gone	Hemlock	3	4 to 7	8			
	Grand fir	3	5 to 6	8			
Primary branches 1/4 gone	Hemlock	3	7	8			
	Grand fir	3	6	9			
First bole break	Hemlock	3	5 to 6	11	2-3/4 [2]	7 to 8	12+ [3]
	Grand fir	3	6	8			
Second bole break	Hemlock	6	6	11+	10	12+	12+
	Grand fir	7	11+	11+			

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[1] Some of the items in the columns above have no entrees because the field notes or data were too inadequate to justify presentation.

[2] Excludes 12 first-year breaks occurring at the point of girdling.

[3] Thirteen percent (11 trees) unbroken 12 years after girdling.

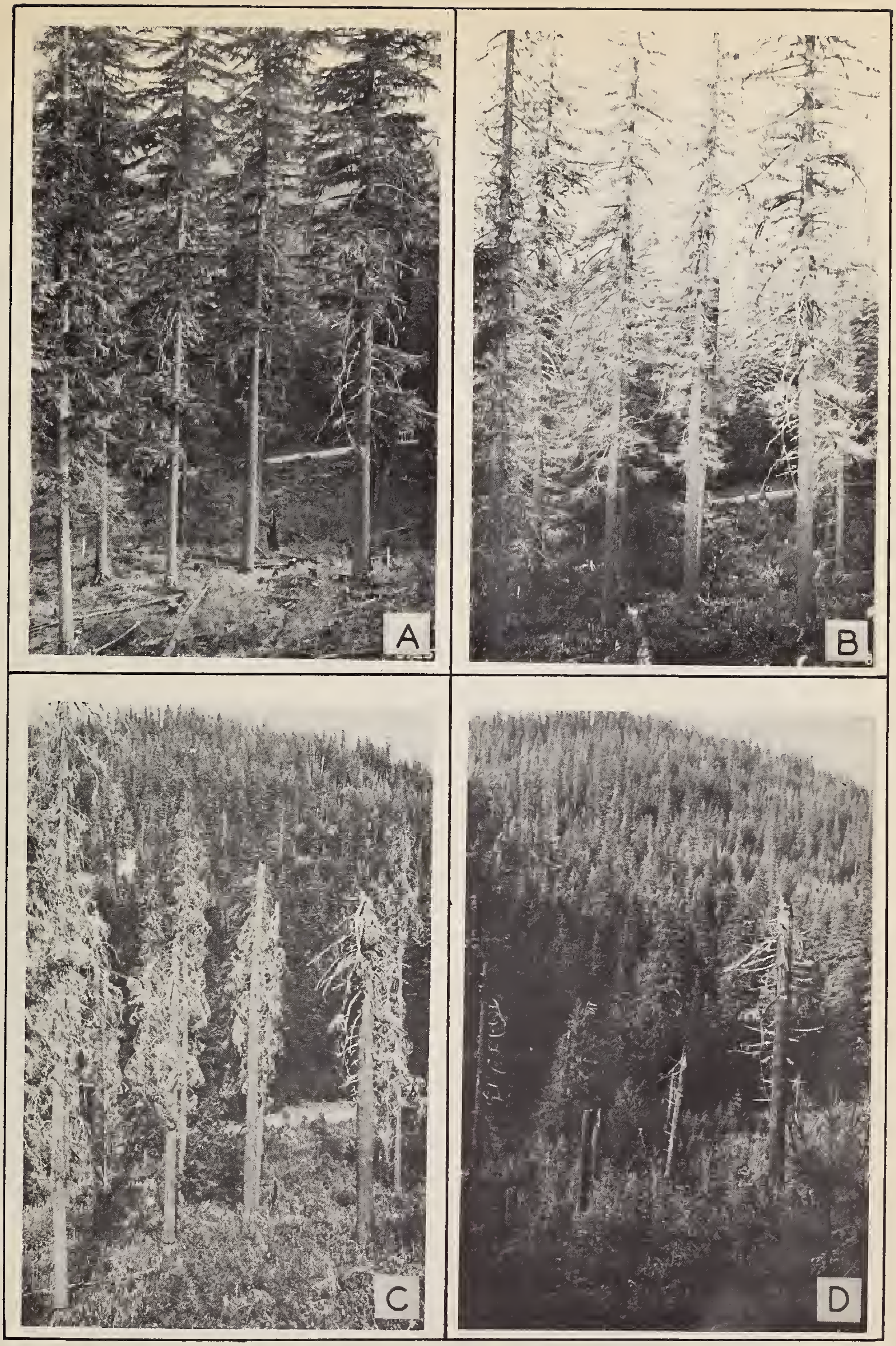

Figure 3.—Girdled western hemlock on Sands Creek, Deception Creek Experimental Forest. A, Five months after girdling, trees are beginning to appear unhealthy; B, four years after girdling, the needles have fallen and the branch system is beginning to disintegrate; C, five years after girdling, most of the trees have broken off once, the bark is cracked and will soon begin to scale off; D, thirteen years after girdling, the trees have all broken off once and many a second time.

Fungi and insects undoubtedly are important factors contributing to the disintegration of girdled trees. The trees on the Sands Creek and Tamarack Hill areas were highly defective before girdling, due to the presence of Indian paint fungus, (Echinodontium tinctorium). The white globular conks of the pouch fungus, (Polyporus volvatus), appeared on nearly every girdled tree on the Sands Creek area. The purple fungus, (Polyporus abietinus), and the bleeding stereum, (Stereum sanguinolentum), were the most common fungi on the Tamarack Hill area. The yellow cap fungus, (Pholiota adiposa), was also found here and on the Sands Creek area. Conks on the trees in both areas were especially common in the girdling notch.

There was considerable activity by wood-boring beetles on the Tamarack Hill area after the girdling. The activity of woodpeckers was also an important factor in breaking up the bark of girdled trees. There appeared to be little insect work on the Sands Creek area.

Damage to Reproduction

Falling limbs and stem sections of girdled trees damaged 3.5 percent of the total reproduction stand on Sands Creek, according to a survey made 11 years after the girdling. The total reproduction stand consisted of 2,144 trees per acre. White pine comprised 17 percent, 365 trees per acre, of the total stand. Six percent of the pine were injured by disintegrating girdled trees. White pine reproduction averaged 11 feet in height at the time of the survey. Grand fir, western hemlock, and western redcedar averaged four to five feet in height.

COST OF GIRDLING

Trees on the Sands Creek area were girdled for an average time expenditure of 36 minutes per tree by CCC axemen. Brewster and Larsen (1) reported a girdling time of five minutes per tree for grand fir and hemlock averaging 14 inches in diameter at breast height. On this basis, a cost of 10 to 15 minutes per tree would be a reasonable production figure for experienced axemen on the Sands Creek area where the grand fir and hemlock averaged 26 and 28 inches in diameter. Experiments in progress at the Deception Creek Experimental Forest indicate that poisoning as a means of removing hemlock may be less expensive and equally as effective as girdling.

It is likely that trees can be felled faster and more cheaply with a power chain saw than they can be girdled with an axe. Of course, where it is necessary to lop, pile, and burn the tops and limbs, the cost of felling will be much higher. Furthermore, felling cull trees sometimes is harmful to neighbor trees and advance reproduction. It appears that girdling (or poisoning) of large, defective trees should be limited to places where only occasional scattered individuals need to be destroyed. Where wholesale destruction of large defective trees is desired, felling and broadcast burning should be considered as an alternative method.

FUEL-TYPE RATING

The fuel-type rating 5/ was "Low-low" 6/ on the Sands Creek and Tamarack Hill areas at the time of girdling. The rating increased to "Extreme-Extreme" when the bark began to loosen four to six years after girdling. As the trees disintegrated further and began to fall, the fuel-type rating decreased until, with only a few broken snags remaining 11 years after girdling, the Sands Creek area rated "Medium-High". The Tamarack Hill area rated a little higher, as there were numerous partially disintegrated and unbroken trees throughout the area. Thus, the fire hazard was still of considerable importance 11 to 12 years after girdling.

The fuel-type rating probably would have been "High-high" immediately after cutting if the trees had been felled instead of girdled. The rating would have decreased thereafter as the finer fuels disappeared and the larger logs absorbed moisture. Compared with felling, girdling has the drawback that it creates standing dead trees which add greatly to the difficulty of forest fire suppression. However, when girdling is limited to scattered individual trees, this disadvantage is of much less consequence. The particular usefulness of girdling in the western white pine type seems to be for the removal of scattered undesirable trees in partially cut areas and in other areas where establishment of new stands of desirable species is wanted.

5/ Based on U. S. Forest Service, Region One, Fuel-Type Standards (1938) and the advice of Ralph L. Hand, Division of Fire Control, U. S. Forest Service, Missoula, Montana, and H. T. Gisborne, Division of Fire Research, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.

6/ In the planning of fire control action in the Northern Rocky Mountain Region, forest fuels are classified and mapped in accordance with their expected rate of spread and resistance to control. Rate of spread refers to the speed that a fire will increase in perimeter and is expressed in chains per hour. Resistance to control refers to the difficulty of building and holding fire line and is expressed in chains of held line per man-hour of work.

Four classes, known as extreme, high, medium, and low, are used in typing both rate of spread and resistance to control. Thus, a given fuel body typed as "High-Medium" has a high rate of spread and a medium resistance to control. The first word in the classification description always refers to rate of spread. The following table illustrates the meaning of each classification:

Rating	Rate of Spread*	Resistance to Control
Extreme	More than 20 chains per hour	0.2 chains per man-hour
High	" " 10 " " "	0.8 " " " "
Medium	" " 8 " " "	2.0 " " " "
Low	" " 6 " " "	3.2 " " " "

*Rate of spread classes are determined by the perimeter increase of the fastest spreading 15 percent of the fires, in each type, during the first three or four hours under class 70 burning conditions.

SUMMARY

Western hemlock and grand fir were girdled on two areas on the Deception Creek Experimental Forest in 1934 and 1935 and the effects observed until 1946. The results were as follows:

1. Cone production was neither increased nor decreased during the first two seasons after girdling while the girdled trees were still physiologically active.

2. Symptoms of vigor decline in the girdled trees first appeared two months after girdling on one area and nine months after girdling on the other area.

3. Girdled trees died within three to four years after treatment.

4. Needle-fall commenced one-third year after girdling. Disintegration of girdled trees progressed gradually from the finer to the coarser branches. Bark on the main stem began to crack and scale off on the majority of trees five to eight years after girdling.

5. Girdled trees began to break off three years after girdling. All of the trees on one area sustained at least one bole-break by eleven years. Second bole-breaks began six to seven years after girdling. Many trees were unbroken on one area twelve years after girdling.

6. Disintegrating trees caused only light damage to the reproduction stand.

7. Girdling cost, using CCC labor, averaged 36 minutes per tree on Sands Creek where trees ranged from 9 to 46 inches d.b.h. It is believed that experienced axemen could have done the job at a labor cost of from 10 to 15 minutes per tree. Poisoning methods now being tested will probably be cheaper than girdling.

8. Fuel-type ratings in the girdling areas ranged from "Low-Low" before girdling to "Extreme-Extreme" six to seven years after girdling. The areas rated "Medium-High" to slightly higher 11 to 12 years after girdling.

9. Girdling is not advisable where large numbers of trees per acre are to be killed because of the extreme fire hazard it creates.

10. Girdling should be useful and cheaper than felling where scattered trees are to be removed.

LITERATURE CITED

(1) Brewster, Donald A. and Julius A. Larsen. 1925.
Girdling as a means of removing undesirable tree species in the western white-pine type. Jour. Agr. Res. 31:267-274.

(2) Pond, James D. 1936.
Girdling for seed production. Jour. For. 34:78-79.

(3) Seifriz, William. 1938.
The physiology of plants. vii & 315 pp., illus., New York.

(4) Watson, R. 1918.
Relation of stimuli to the cone production of western hemlock. Jour. For. 16:168-175.

LIST OF PREVIOUS PUBLICATIONS IN THIS SERIES

Station Paper No.	
1	* A preliminary study of root diseases in western white pine, by John Ehrlich. Oct. 1939.
2	* Possibilities of partial cutting in young western white pine, by E. F. Rapraeger. Jan. 1940.
3	* Blister rust control in the management of western white pine, by Kenneth P. Davis and Virgil D. Moss. June 1940.
4	Possibilities of wood-pulp production in the northern Rocky Mountain region, by E. F. Rapraeger. Mar. 1941.
5	Results to date of studies of the durability of native woods treated and untreated, by C. N. Whitney. Rev. Jan. 1946.
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12	Forest resource statistics, Cascade County, Montana, by H. J. Pissot and E. F. Peffer. Apr. 1948.
13	Forest resources of northern Montana. C. W. Brown and W. C. Hodge. June 1948.
14	List of publications available for distribution or loan, 1910 through 1947. NRM Station. June 1948.
15	Review of published information on the larch-Douglasfir type, by Russell K. LeBarron. November 1948.
16	Development of a blister rust control policy for the national forests in the Inland Empire, by Donald M. Matthews and S. Blair Hutchison. Dec. 1948.

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